SUSTAINABLE BUILDING MATERIAL FOR GREEN BUILDING CONSTRUCTION, CONSERVATION AND REFURBISHING

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3 authors, including:

Usman Aminu Umar
Universiti Teknologi PETRONAS

Dr. Mohd Faris Khamidi
University of Reading Malaysia

SUSTAINABLE BUILDING MATERIAL FOR GREEN BUILDING CONSTRUCTION, CONSERVATION AND REFURBISHING

Usman Aminu Umar[1, a*], M. F. Khamidi[2, b] and Hassan Tukur[3, c]

[1, 2] University Technology Petronas/Civil Engineering Department, Perak, Malaysia

[a]Email: usman_g0189@utp.edu.my, [b]Email: mfaris_khamidi@petronas.com.

[3] Tianjin University of Technology/Mechanical Engineering Department, Tianjin, China.

[c]Email: tingilin@yahoo.com

***Abstract*—Materials are the essential components of buildings construction. Chemical, physical and mechanical Properties of materials as well as an appropriate design are accountable of the building mechanical strength. The design of green buildings should thus begin with the selection and use of eco-friendly materials with related or better features than traditional building materials. Building materials are usually selected through functional, technical and financial requirements. However, with sustainability as a crucial issue in the last decades, the building sector, directly or indirectly causing a considerable portion of the annual environmental deterioration, can take up the obligation to contribute to sustainable development by finding more environmentally benign methods of construction and building. Among the directions for solutions is to be found in new material applications, recycling and reuse, sustainable production of products or use of green resources, Careful selection of eco-friendly sustainable building materials may be the fastest way for builders to start integrating sustainable design concepts in buildings. Ordinarily, price has been the primary consideration when comparing related materials or materials selected for similar purpose. Nevertheless, the price of a building element signifies just the manufacturing and transportation costs, not social or environmental costs. Substantial initiatives have been carried out by the research community globally, in order to discover alternative sustainable building materials and low technology techniques, which result in a more sustainable and affordable construction complying with the comfort standards required today. Embracing green building materials is a good alternative to meet to this objective. Therefore, Selection of construction materials that have minimum environmental burdens is useful in the sustainable development of a nation. The purpose of this paper is to highlight how sustainable building material can contribute to lessen the impact of environmental degradation, and generate healthy buildings which can be sustainable to the occupant as well as our environment.**

***Keywords*—Sustainable Building, Sustainable Materials, Green Building, Construction Industry.**

I. INTRODUCTION

Buildings have a tremendous impact on the environment, using about 40% of natural resources extracted in industrialized nations [1], consuming virtually 70% of electricity and 12% of potable water [2], and producing between 45% and 65% of the waste disposed in our landfills [3]. Additionally, they are responsible for a massive amount of harmful emissions, accounting for 30% of greenhouse gases, due to their operation, and an additional 18% induced indirectly by material exploitation and transportation [3-4]. Simultaneously, the bad quality of indoor environments may result in health issues to employees in office buildings, hence, reducing efficiency [5]. Also Building construction consumes 40% of the raw stone, gravel, and sand used worldwide annually, and 25% of the raw timber. From the environmental impact perspective, the building sector has a significant effect on the entire environment [6]. Residential buildings represent a large percentage of the built environment, and the selections of materials and layouts are necessary for the general sustainability.

Considerable initiatives have been carried out by the research community worldwide, in order to find alternative sustainable building materials and low technology methods, which result in a more sustainable and affordable construction adhering to the comfort standards needed today. Adopting green building materials is an excellent approach to meet this target. Selection of construction materials which have minimum environmental burdens is useful in the sustainable development of a country. Therefore, building related contribution to environmental issues is large and therefore essential. Selecting environmentally preferable building products is an excellent method to boost a buildings environmental performance.

While there is obviously an immediate need for new technologies to optimize the application of low-impact building materials, it is also true that there are several technologies or systems, currently in use [7, 8, 9]. Many have originated from an earlier influx of sustainable housing activism and development, prompted by the 1970s environmental movement [8-10], and then boosted by the force for better energy efficient buildings [10]. their strategy has been referred to as effective in spreading ideas about best practice to dedicated green advocates, builders and individuals seeking for an alternative means of determining the material-selection process, very few such systems are available that support the effective and substantial use of local and recycled building materials in the design-decision making phase of a building [8, 9]. The objective of the study is to possible explore and highlight how sustainable building material can contribute to lessen the impact of environmental degradation, and create healthy buildings which can be sustainable to the occupant as well as our natural environment.

II. Development of Green Building

In order to mitigate the effect of buildings along their life cycle, Green Building (GB) has become a new building philosophy, pushing the application of more environmentally friendly materials, the implementation of strategies to save resources and lower waste consumption, and the improvement of indoor environmental quality, among others [11, 12]. This might lead to environmental, financial, economic, and social benefits. For instance, savings in operation and maintenance costs in GBs can be realized through the installation of high-efficiency illumination and insulation systems[13] or through a suitable material selection process that considers, for example, the daylight roof reflection[11,14,]. Other primary advantages of GBs related to indoor environmental quality advancements are the reduction on health costs and the increase on employees' productivity [13, 15, 16] through their perceived satisfaction towards work areas [17]. Furthermore, intangible benefits, such as the building and builder's goodwill, and perceived added value must also be considered [13, 18, 19] simply because they could guide the decisions of investors and future owners [15, 19]. Despite their demonstrated benefits, GBs are not yet regarded as attractive projects since most builders relate green features with expensive technologies that increase cost (e.g., photovoltaic panels, grey water reuse systems)[20,21]. Nevertheless, a careful design process and a comprehensive material selection method, rather than an elevated investment in technology, may be sufficient to accomplish ideal environmental objectives at a lower cost. In reality, some research supports the insufficient difference between the average investment cost per square foot for some GBs, such as academic buildings, laboratories, community centers, and ambulatory care facilities, and that of non-green buildings with the same characteristics [20]. Moreover, GBs provide better dividends in the long run [13, 15, 16] recovering up to 10 times the green premium through the realization of anticipated benefits [16]. The achievements of a GB will depend on the quality and effectiveness of the installed green systems. Therefore, the market demands a common approach to distinguish GBs from traditional buildings through the use of standard, transparent, objective, and verifiable measures of green that will ensure that the minimum green requirements have been achieved.

A. Building materials problem

The material challenge for buildings usually takes various forms. As stated, the grey energy and emissions must be regarded, and the production of building materials involves the use of more high value energy and resources in comparison with building operations. There are also environmental issues with the by-products of material used in buildings, and there are limitations on the extraction of resources used in numerous building ingredients. One should additionally consider the infrastructure used to support the built environment. There are lots of technological advances that need to be carried out to resolve the complications of resource depletion, corrosion, pollution, durability, lifespan, etc. related to building materials. Firstly, new construction needs to be constructed more sustainably so that it not just reduces negative aspects of construction and operations, but that it primary boosts building lifespan, which can be carried out by eliminating design features that will be rapidly outdated. Also all required factors with minimal lifespans should be designed for recycle or raw-material-recovery. This must be attained in all aspects by carefully breaking down the complexity of the building into its components, and comprehending virtually any trade-offs among integrated systems so that a completely sustainable solution can be achieved. This can be assisted by an awareness of the rapidly growing array of materials readily available for build structures, enclosures and systems.

Lastly, with regards to the end of lifetime of a building, there needs to be extremely careful consideration for the processing of the materials. This should be considered previously during the design stage of any building, where composites that are hard to handle are minimized. Materials should be used that can be immediately recycled without the need to remanufacture them. If they cannot be immediately reused, they can be recovered as raw materials. If they should be reused, they should be utilized at the same level of quality, thereby eradicating any down cycling or waste.

B. Material selection

The application of stable, attractive, and environmentally responsible building materials is a key ingredient of any high-performance building effort. The utilization of natural and healthy materials contributes to the well-being of the occupants and to a feeling of connection with the bounty of the natural world. Many building materials have considerable environmental effects from pollutant releases, habitat destruction, and depletion of natural resources. This will happen during extraction and acquisition of raw materials, production and manufacturing processes, and transportation. In addition, some construction materials may harm human health by exposing workers and building occupants to toxic and hazardous chemicals. Consequently, recognition and selection of environmentally preferable materials for use in construction activities at pre building phase present an opportunity to restrict such environmental and human health impacts. Selecting environmentally attractive materials with minimized environmental impacts is generally achieved through the process of resource conservation and selection of non-toxic materials.

The resources used to manufacture construction materials affect the environment by depleting natural resources, using energy, and releasing pollutants to the land, water, and atmosphere. Materials which contain irritating, odorous, hazardous, or toxic elements adversely impact human overall health throughout-gassing of volatile components or direct contact. Preferably, materials selections can be made based on a rigorous assessment of environmental burdens through-out the entire of the product or material. This process, referred to as *environmental life-cycle assessment*, is rarely feasible for most building procurement decisions. It is possible, however, to apply life cycle thinking to evaluate what is known about the environmental performance of products and make wise selections.

III. SUSTAINABLE BUILDING MATERIALS LIFE CYCLES

Evaluation of building products, from the gathering of raw materials to their ultimate disposal, gives a better perception of the long-term costs of materials. These costs are paid not merely by the client, but also by the owner, the occupants, and the environment. The principles of Life Cycle Design offer essential guidelines for the selection of building materials. Every phase of the manufacturing process, from gathering raw materials, manufacturing, distribution, and installation, to ultimate recycle or disposal is inspected for its environmental impact. A material's life cycle could be well organized into three stages, Pre-Building, Building, and Post-Building [22]. These stages parallel the life cycle phases of the building itself. The assessment of building materials' environmental impact at every phase enables a cost-benefit analysis over the lifetime of a building, instead of merely an accounting of initial construction costs.

A. Pre-Building phase

The Pre-Building Stage explains the production and delivery process of a material up to, but not including, the point of installation. This consists of finding raw materials in nature as well as extracting, manufacturing, packaging, and transportation to a building site. This particular stage has the most possibility of creating environmental destruction. Knowing the environmental impacts in the pre-building phase will result in the wise selection of building materials. Raw material procurement methods, the manufacturing process itself, and the distance from the manufacturing location to the building site all have environmental implications. An understanding of the beginning of building materials is vital to an understanding of their collective environmental impact when indicated in the sort of a building [22].

B. Building phase

The Building Stage refers to a building material's useful life. This stage commences at the point of the material's assembly into a structure, involves the maintenance and repair of the material, and goes all over the lifetime of the material within or as part of the building. The material waste generated on a building construction site can be considerable. The selection of building materials with regard to minimized construction waste, and waste that can be reused is crucial on this stage of the building life cycle. Long-term exposure to specific building materials may be harmful to the overall health of a building's occupants. In spite of an increasing awareness of the environmental health problems regarding exposure to a number of products, there is little focus in reality schools on picking materials based on their potential for out gassing harmful chemicals, demanding regular maintenance with such chemicals, or requiring regular replacements that perpetuate the exposure cycle.

C. Post-Building phase

The Post-Building Stage refers to the building materials when their performance in a building has run out. At this stage, a material could possibly be recycled in its entirety, have its elements reused back into other goods, or perhaps be thrown away. From the perception of the designer, perhaps the minimum measured and least recognized stage of the building life-cycle occurs when the building or material's useful life has been exhausted. The demolition of buildings and clearance of the resulting waste has a substantial environmental cost. Degradable materials may generate harmful waste, alone or even in mixture with many other materials. Inert materials consume gradually scarce landfill space. The adaptive recycle of a present structure sustains the energy that went into its materials and construction. The energy embodied in the construction of the building alone and the manufacture of these materials will be wasted if these resources are not effectively utilized.

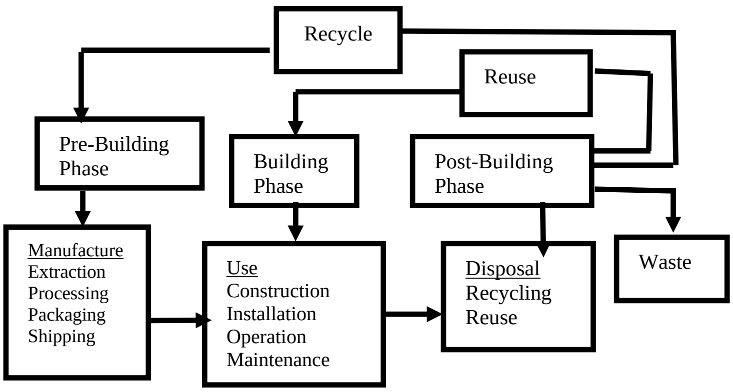

Figure 1: Three phases of the Sustainable building material life

IV. COMPONENTS OF SUSTAINABLE BUILDING MATERIALS

Generally, cost has long been the primary consideration when assessing related materials or materials selected for similar function. Meanwhile Experts selected three categories of criteria, in accordance with the material life cycle, which can be used in considering the environmental sustainability of building materials. The existences of one or two of these components in building materials allow it to become environmentally sustainable. Some of the components of sustainable building material widely known are listed in table 1 below.

Table 1: Component of Sustainable Green Materials

Component of Sustainable Green Materials		
Manufacturing Process (MP)	**Building Operations (BO)**	**Waste Mgmt. (WM)**
Waste Reduction (WR) Pollution Prevention (P2) Recycled (RC) Embodies Energy Reduction (EER) Natural Materials (NM)	Energy Efficiency (EE) Water Treatment & Conservation (WTC) Nontoxic (NT) Renewable Energy Sources (RES) Longer Life (LL)	Biodegradable (B) Recyclable (R) Reusable (RU) Others (O)

V. PRINCIPLES OF SUSTAINABLE BUILDING DESIGN

In the CIB report on agenda 21 on sustainable construction, states that different nations have their own different strategy and priorities regarding principle of sustainable construction [22]. The report additionally suggests that the primary focus of sustainable construction and design in universal approach is ecological impact to the environment. Fisher outlined five principles of sustainable design in which sustainable building material had been highly recommended [23].

A. Healthy interior environment

All possible measures are to be taken to ensure that materials and building systems do not emit toxic substances and gasses into the interior atmosphere. Additional measures are to be taken to clean and revitalize interior air with filtration and planting.

B. Energy efficiency

All possible measures are to be taken to ensure that the building's use of energy is minimal. Cooling, heating, and lighting systems are to use method and products that conserve or eliminate energy use.

C. Ecologically benign materials

All possible measures are to be taken to use building materials and products that minimize destruction of the global environment.

D. Environmental form

All possible measures to be taken to relate the form and plan of the design to the site, the region, and the climate. Measures are to be taken to relate the form of building to a harmonious relationship between the inhabitant and nature.

E. Good design.

All possible measures are to be taken to achieve an efficient, long lasting, and elegant relationship of use areas, circulation, building form, mechanical systems and construction technology.

Additionally, Kim and Rigdon [24] highlight about three major principles on sustainable design which are shown in figure 2, as the matter of fact, this principles deal with an economic sustainability, a functional sustainability, an environmental sustainability, a social and human sustainability.

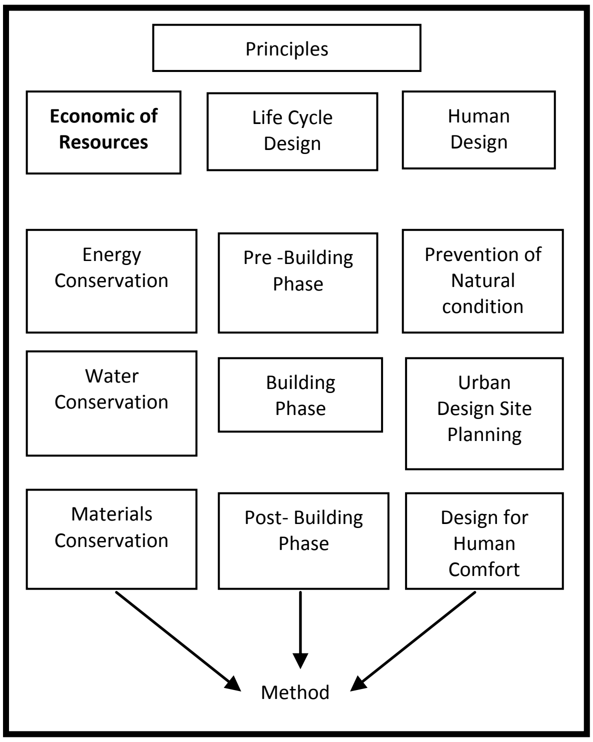

Figure 2: conceptual framework for sustainable design and pollution prevention in architecture

VI. CONCLUSION

Sustainable building materials by definition are materials which are domestically created and sourced which decreases transportation costs and CO_2 emissions, they could consist of reused materials, they possess a lower environmental effect, they are thermally effective, they need less energy than conventional materials, they make use of renewable resources, they are lower in harmful emissions and they are economically sustainable.

A sustainable building material needs to be used properly and contextually in every community development. The application of sustainable building materials not just minimizes transport costs, carbon emissions, and in most cases materials costs, it also offers employment and skills development opportunities for community members.

Sustainability as an alternative criterion for building materials are generally chose through functional, technical and economical specifications. Nevertheless, with sustainability as a crucial challenge in the past decades, particularly in developed nations, the environmental load of building materials additionally become a more significant requirement. The construction sector, directly or perhaps indirectly creating a substantial portion of the annual environmental destruction, may take up the obligation to promote sustainable development by finding more environmentally kind approaches to construction and building. Among the directions for solutions is to be seen in new material applications, recycling and reuse, sustainable manufacture of products, or use of green resources.

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